Eng. pat. F.'S

VALMET Oy
RAUTPO[illegible]AN TEHDAS

PATENT SPECIFICATION

1288277

DRAWINGS ATTACHED

(21) Application No. 56701/69 (22) Filed 19 Nov. 1969
(31) Convention Application No. 795954 (32) Filed 3 Feb. 1969 in
(33) United States of America (US)
(45) Complete Specification published 6 Sept. 1972
(51) International Classification D21F 9/02
(52) Index at acceptance
D2A 4 7A2 7B12 7B13 7B14 7B15 7B2 7B27 7B29 7B5 7B6

1288277

THE PATENT OFFICE LONDON

(54) IMPROVED TWIN WIRE FIBROUS WEB FORMING APPARATUS

(71) We, BELOIT CORPORATION of Beloit, Wisconsin 53511, United States of America, County of Rock and State of Wisconsin, United States of America, a corporation organised and existing under the laws of the State of Wisconsin, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to fibrous web formation, and more particularly to improving twin wire apparatus for making fibrous webs from a dilute aqueous suspension of fibres.

In relatively recent years, the art of paper-making has undergone a number of significant advances in the field of paper web formation using two opposed forming wire runs for web formation between them as contrasted to the heretofore more conventional Fourdrinier-type paper-making machines which form a single forming wire run. Although such twin wire forming machines have met with limited commercial success, these machines are still in the stage of being improved and various aspects of the operation thereof and the resulting quality of paper may leave something to be desired, at least in certain specific instances. For example, as the speed of the paper machine is increased, operational difficulties are often encountered in connection with the deposition of certain type of stock requiring rather high dilution. The problems encountered are not limited to difficulties in control of water movement (with resulting "rolling" and/or "streaking") but include difficulties of web-sensitivity at such speeds, premature wear of the various components, control of pressure applied on the new web, and so on. Essentially, the present invention provides a new and unique fibrous web forming apparatus which accommodates higher paper machinery speeds as well as improving quality of paper so-made.

It is therefore an important object of the invention to provide an apparatus for effecting improved paper making quality of high speeds.

It is another object of the invention to provide a paper-forming section of the apparatus overcoming, at least to a degree, the aforesaid difficulties.

It is yet a further object of the invention to provide a compact twin-wire forming section of the apparatus allowing increases in operational speed and/or web-weight without increase in machine dimension.

The invention provides apparatus for forming fibrous webs comprising two looped formaminous wires disposed in continuous loops or runs, and a headbox for introducing paper-making stock between the wires at an entrance mouth defined by opposed parts of the wire loops or runs, said opposed parts extending round a stationary curved guide having a large radius of curvature and a rotatable guide having a substantially smaller radius of curvature than that of the stationary guide, the stationary guide and the rotatable guide being positioned within the loop of one of the wires and urging the said one of the wires toward the second of the wires.

Other and further objects, features and advantages of the present invention will become apparent to those skilled in the art in the following detailed disclosure thereof in conjunction with the drawings attached hereto and in which:—

Figure 1 is shown essentially as a schematic elevational view illustrating one embodiment of the invention;

Figure 2 is an essentially schematic elevational partial view of another embodiment of the present invention; and

Figure 3 is essentially a schematic elevational partial view of yet a further embodiment of the present invention.

Figure 1 illustrates a forming-section 10 of a paper-making machine. A headbox 11 is connected to, a slice chamber 11a, having a plurality of simultaneously converging side walls 11b, 11b' and an outlet 11c. The headbox provides a supply of paper stock to

[Price 25p]

the slice chamber. The slice outlet 11c is positioned at the upstream end of the forming section 10. The upper side wall 11b' is provided with an adjustable lip 11c for selectively adjusting the size of the slice opening 11e. A power adjustment means PA is positioned above the movable lip 11c for selective adjustment as indicated. A plurality of trailing members 12 which have a degree of flexibility, are mounted within the slice chamber 11a. It will be noted that the trailing members 12 diminish in cross-sectional area toward the slice opening 11e. The trailing members 12 define a plurality of converging channels 13 allowing passage of paper stock therethrough toward the opening 11e. Thus, an essentially symmetrical slice chamber is attained. The slice chamber 11a is exceptionally well suited for producing a dilute aqueous suspension of entangled co-moving fibres having a relatively low degree of turbulence and a relatively high degree of dispersion exiting downstreamwise from the slice opening 11e as a high-speed substantialy uni-directional ribbon-thin jet-stream. However, it will be appreciated that other slice chambers producing the desired characteristics within the jet-stream may also be utilized.

Two breast rolls 15 and 16 are mounted for rotation in working relationship with the slice chamber 11a and spaced apart a distance somewhat greater than said ribbon-thinness of the jet-stream to define a gap G therebetween.

A first forming wire F_1 wraps the first breast roll 15 and travels around the roll therewith through the gap G, while a second forming wire F_2 wraps the second breast roll 16 and travels around the roll 16 and through the gap G. The forming wires are respectively trained over a plurality of wire guides 18, 19, 21 and then respectively over guides 23 and 15a, and 24 and 16a to define first and second runs. For sake of convenience, the first wire and the first wire run will be referred to by the reference numeral F_1 while the second wire and second wire run will be referred to by the reference numeral F_2. These forming wires may be composed of bronze, steel, copper, plastic or even fabric strands woven in an open mesh to define endless loops. The forming wires may also be formed of a plurality of different materials combined to yield certain specific characteristics, i.e., wear, stretch, weight, strength and so on.

It was previously indicated that the jet-stream of stock impinges into the gap G between the rolls 15 and 16, but, however, it will be noted that in fact the jet-stream impinges on the surfaces of the forming wires F_1 and F_2 as they travel over the rolls 15 and 16, and that it contacts one of the wires, i.e., F_1 before the other. Dewatering begins to occur at the immediate off-running side of the rolls 15 and 16 by essentially a drainage phenomenon without any "pumping" by the rolls. Pumping may be generally defined as the action of a divergent solid surface acting on a moving moist web by creation of at least partial vacuum at the off-running side of such a surface which tends to pump or pull water from the web. During early stages of web formation pumping is detrimental to proper fibre distribution and thus to be avoided. At this early stage of the forming section, substantially little, if any, pressure is exerted on the paper stock. This "easy" pressure (explained more fully hereinafter) allows a substantial portion of the water to be drained from the forming-zone without application of disruptive pressure, which may cause shearing or like effects disturbing the formation of the web. The dewatering, as indicated at a first area A_1 and at a second area, A_2, is in substantially opposing directions so that simultaneous drainage, without pumping, takes place along both surfaces of the newly forming web allowing proper distribution of the fibres within the web. The forming wires F_1 and F_2 continue to travel together convergingly into general parallelism over the third wire guide 18. The term " general parallelism" as used herein will be understood to include the dynamic or changing relation to the wires toward one another as caused by the slight spacing or separation of such wires by the sandwiched web therebetween and permit the slight movement of the respective wires toward one another as water is removed from the newly forming web. As will be appreciated, as the paper stock (sometimes referred to as the "jet-stream") is dewatered, the wire tension urges the wires closer toward on another due to the smaller quantity of matter between such wires. Thus, the tensioning of the respective wire runs materially aids in properly dewatering the forming web.

The wire guide 18 is essentially an elongated, smooth, stationary generally convexly-curved surface urging the wire F_2 into general parallelism (as defined hereinbefore) with the wire F_1, which is free from restraining means throughout this portion of the forming-zone. In the embodiment illustrated in Figure 1, the wire guide 18, is shown as being water-impermeable but, however, as will be discussed in relation to Figure 3, it may also be water-permeable. The generally elongated curvature of the wire guide 18 allows the application of "easy" pressure, i.e., a gradual build-up of pressure between the forming wires and avoids spreading or spewing a large volumes of water from between the wires causing flow disturbances due to relatively abrupt and/or intensified pressure changes between such wires. In addition, the general curvature of the wire guide 18 allows little if any normal loading of the travelling wire F2 against the wire guide 18 and that the greatest loading actually

occurs at the off-running side of the wire guide 18. In this manner, substantially little wear takes place along the surface of the wire guide 18 since a minimal amount of frictional contact between the moving wires and the stationary surface takes place. It will be noted that the forming wires F_1 and F_2 do not come into actual parallelism (as explained hereinbefore) with one another until some point 18a well beyond the leading edge of the wire guide 18. During this gradual convergence of the wires into general parallelism additional pressure is exerted upon the newly formed web to express additional water therefrom. The water is thrown through and away from the exposed side of the forming wire F_1 which is, of course, free from contact with restraining means at the forming zone. The expressed water is collected in a saveall device 17 having a conduit C directing the expressed white water back to the headbox or other desired location. A conventional doctor means 16b is trained on the off-running side of the roll 16 to remove any adherent water and other particles off the surface of the roll 16 and direct the same into the saveall device 17.

A large diameter foraminous roll 19 (the fourth wire guide) is positioned downstream of third wire guide 18 and, preferably, immediately downstream of the off-running side of the wire guide 18, to define with the latter a continuous bi-radii path of travel having a first radius of curvature substantially larger than the second radius of curvature. The roll 19 is shown as being an open breast roll having a perforated surface 19a receiving the travelling sandwich arrangement of wire-web-wire. As will be appreciated, dewatering takes place on both sides of the sandwich arrangement, i.e., water tends to be thrown away from the wire F_1 by virtue of centrifugal force and into the openings of the roll 19 by virtue of positive pressure between the wires.

The relatively large radius of curvature of the wire guide 18 substantially prevents normal or perpendicular loading of the wires F_1 and F_2 against the surface of the wire guide 18. In this manner, relatively little wear takes place between the travelling wires and the stationary wire guiding surface 18a. The greatest amount of wire loading occurs when the wires come in contact with the rotary surface of the formaminous roll 19. Since the surface of the roll 19 is rotating, substantially little frictional force is developed between the surface of the roll and the travelling wires so that no detrimental effects are encountered by the virtue of the increased loading on the wires. The roll 19 guides the travelling wires through a substantial curve of, for example, about 90° in a direction away from the jet-stream direction at the slice or gap G. The rate of turn through which the travelling wires are forced by the surface of roll 19 is sufficient to cause dewatering to occur by driving water through and away from the exposed side of the forming wire F_1. As will be noted, the exposed, or the inner peripheral side of the forming wire F_1 is free from restraining means throughout the forming-zone. The roll 19 driven by virtue of tension in the travelling wire F_2 runs substantially at the jet-stream speed so that there is no relative movement between the travelling wire runs and the supporting surface of the roll. Further, at this stage of the forming-zone, the newly formed web is still in a relatively fluid state and the relative shifting between the wires as they travel over the rather abrupt curvature of the guide roll 19 does not cause shearing or the like to take place within the newly forming web. In other words, some relative movement between the two wires can be tolerated at this relatively early stage of the forming-zone.

A laterally continuous dewatering means 19b is trained on the exposed inner side of the forming wire F_1 at the immediate off-running side of the wire guide 19. The watering means 19b is placed in extremely close working relationship with the travelling wire runs to "skim" off water that may be adhering to the forming wire runs. The dewatering means 19b thus engages and removes water that is adhering to the wire runs but does not cause any wire-directional changes and there is little, if any, frictional engagement between the travelling wires and the dewatering means 19. The dewatering means 19b removes the water from the wire runs and throws it into the saveall device 17 having the appropriate conduit C passing the expressed water to a desired location. As indicated hereinbefore, the abrupt change of direction that the travelling wires are forced to undergo by virtue of the surface of the wire guide 19 causes the water within the newly formed web to be thrown through and away from the exposed side of the forming wires. The wire tension continually urges the wires toward one another to drive water from the sandwiched web while the abruptly curved surface provides momentum to the expressed water along the surfaces of the wires away from the web. In other words, centrifugal force and gravity are combined to effect a substantial amount of dewatering at the area of curvature of the guide roll 19.

The two wire runs then continue in general parallelism over the fifth wire guide 21 which prevents a water-removing surface, shown in Figure 1 as a plurality of suction boxes acting against one surface of the sandwich arrangement. It will be noted that during the initial travel of the sandwich arrangement over the water-removing surface of the wire guide 21, the inner peripheral surface of the forming-wire F_1 is free from contact with restrain-

ing means while the inner peripheral surface of the forming-wire F_2 is in contact with the suction boxes of the wire guide 21 for removal of water therethrough. During the latter portion of the travel of the sandwich arrangement over the suction boxes, the reverse occurs, i.e., a suction box 21a contacts the inner peripheral surface of the forming wire F_1 while the inner peripheral surface of wire F_2 is free from contact with restraining means. The newly formed web tends to adhere along the surface of the wire F_1 and continues to travel therethrough while diverging from the forming wire F_2. The forming wire F_2 is guided around the turning roll 24 and along a plurality of the guide rolls 16a back to the upstream portion of the forming section 10. The guide rolls 16a may be provided with tensioning means T_2 substantially as indicated to maintain the desired degree of tension within the wire run.

The first forming wire F_1 carrying the newly formed web W along its outer surface continues to travel downwardly contacting the turning roll 23, in this case functioning as a couch roll by virtue of its suction gland 23a. The turning roll 23 directs the forming wire F_1 and the web W away from the forming section and toward a pick-up station. The pick-up station is defined by a roll 25 which is wrapped by a pick-up felt PF. The roll 25 is provided with a suction gland 25a which is maintained under subatmospheric pressure. The pick-up felt PF contacts the newly formed web as it travels past the roll 25 and causes it to adhere to the pick-up felt and travel therewith toward a further station for processing as desired. The pick-up felt PF is, of course, trained around a plurality of guide rolls (not shown) defining its looped path of travel in a conventional manner. The forming wire F_1 continues to travel upwardly past a plurality of the guide means 15a directing the wire F_1 back to the upstream section 10 of the paper machine. The guide rolls 15a may be provided with tensioning means T_1 substantially as indicated. In addition, the guide rolls 15a may be provided with a doctor blade 15b on their off-running sides to cleanse the peripheral surfaces thereof. The doctor blade 15b directs the removed material into the saveall device 17. Drive means M_1 and M_2 are connected to certain of the rolls within the wire runs F_1 and F_2. In the embodiment shown in Figure 1, the guide rolls 23 and 24 are respectively connected to drive means M_1 and M_2, but, however, other rolls may also be connected to such drive means if desired. The drive means urge the respective wire runs at speeds substantially equal to the jet-stream speeds as indicated hereinbefore.

Referring now to Figure 2 wherein a further embodiment of a forming-section 20 of a paper machine is illustrated, the headbox 11, along with the slice chamber 11a is shown as being oriented to have its outlet 11e directed in an upward direction. The slice chamber 11a is also provided with a plurality of converging trailing members 11b defining a plurality of converging channels extending from the headbox toward the outlet opening 11e. As indicated hereinbefore, the converging trailing members 11b have a degree of flexibility allowing them to assume hydrodynamic stability within the paper stock flow. By positioning the entire headbox 11 upward, the bottom apron member of the headbox need not be curved and the opening 11e may be positioned much closer to the forming gap G.

Two breast rolls 15 and 16 are mounted for rotation and are spaced apart a distance to define a somewhat vertically-extending gap G between them. The gap G is in close working relationship with the slice opening 11e to receive the jet-stream of paper stock therefrom. The rolls 15 and 16 are wrapped by forming-wires F_1 and F_2 respectively and guide such forming-wires through the gap G. As indicated hereinbefore, it is not necessary to align the roll axis along any particular plane as long as the guide the wires into closely spaced relation in the vicinity of the slice opening. The forming wire F_1 is a substantially continuously looped travelling wire having a path of travel defined by a plurality of wire guides 15, 18, 19, 21, 23 and finally 15a to define a first wire run. The second forming wire F_2 is similarly a looped travelling forming wire having a path of travel defined by a plurality of wire guides 16, 18, 19, 21, 24 and 16a to define a second wire run. Wire guides 15a and 16a may be provided with tensioning means T_1 and T_2 respectively for maintaining a desired degree of tension within their respective wire runs.

As the paper stock is discharged in a low-turbulence, high-dispersion jet-stream toward the forming gap G, it contacts the porous surfaces of the forming wires F_1 and F_2. The speed of the jet-stream is sufficient to cause the water to be driven through the exposed surfaces of the forming wires at the immediate off-running side of the breast rolls 15 and 16 by a drainage phenomena, without disruptive pumping taking place. In this manner, a first dewatering area A_1 occurs through the forming-wire F_1 and a second dewatering area A_2 occurs through the forming-wire F_2 so that substantially equal drainage takes place along opposed sides of the newly forming web. The travelling wires continue to converge together into general parallelism as they travel over the wire guide 18. The wires actually assume general parallelism (as defined earlier) at a point 18a along the surface of the wire guide 18 so that a gradual build-up of pressure occurs throughout the area of convergence. As the wires con-

tinue converging together, the exposed side of the forming-wire F_1 is free from contact with restraining means allowing a third dewatering area A_3 to occur driving water through and away from the forming-wire F_1.

The wire guide 18 is substantially a stationary, smooth, generally convexly curved surface having a relatively large radius of curvature. The large radius of curvature prevents any substantial loading of the wires against the surface of the wire guide 18 so that relatively little frictional engagement takes place between the stationary surface and the travelling wire runs. At the immediate off-running side of wire guide 18 a large diameter foraminous roll 19 presents a rotary surface to the travelling wire runs carrying the newly formed web therebetween in a sandwich arrangement. The foraminous roll 19 is provided with an "open" structure 19a wherein the inner peripheral surface of the roll 19 is provided with a plurality of pins or support structures carrying an outer water-permeable water mesh or the like of conventional construction. The roll 19 is positioned in close running relationship with the off-running side of the wire guide 18 so as to provide an essentially continuous path of travel for the sandwiched arrangement of the travelling wires and the newly formed web. The rotating surface of the roll 19 offers essentially no frictional drag on the travelling wires and directs the same through a rather abrupt curve in relation to the jet-stream direction at the forming gap G. The abrupt change of direction causes additional water to be removed from the sandwiched arrangement at a further dewatering area A_4. Of course, water is also driven in an opposing direction into the openings 19a of the roll 19. A saveall device 17 is positioned in the vicinity of the various dewatering areas to receive the expressed white water for collecting the same and delivering it via a conduit C back to the headbox for dilution of the paper stock or to another location as desired.

A doctor blade means 16b is provided on the off-running side of the breast roll 16 for cleaning its peripheral surface from any adherent water-droplets or other foreign material. A laterally continuous dewatering means 19b is trained on the inner peripheral surface of the forming-wire F_1 on the immediate off-running side of the roll 19 to remove any adherent water droplets from such wire surface. The dewatering means 19b may be of any structure desired but, however, preferably it is an "air-foil" such as shown and claimed in U.S. Patent No. 3,377,236 comprising a stationary dewatering element having a rounded lead edge which engages water carried along the exposed surface of the forming-wire F_1 without causing any wire-directional-changing engagement with the travelling wires. The sandwich arrangement continues travelling in a downward direction until it contacts the further wire guide 21.

The wire guide 21 presents a water-removing surface to the sandwich arrangement, whereby water is withdrawn through the inner peripheral side of the forming-wire F_2 while the inner peripheral side of the forming-wire F_1 is free from contact with restraining means. The water removal surface is shown as a plurality of suction boxes which are maintained under subatmospheric pressure to aid in the water removal function. At the immediate off-running side of the wire guide 21 a further suction box 21a is positioned in working relationship on the inner peripheral surface of the forming-wire F_1 for additional dewatering along the opposed surface of the sandwich structure. The newly formed web tends to adhere to the forming wire F_1 and depart from the other forming wire F_2. The wire F_1 and the newly formed web W continue to travel until they contact the rotary surface of the roll 23 and a suction gland 23a. The roll 23 here functions as a couch roll and guides the forming-wire F_1 and the newly formed web W away from the forming-section and toward a pick-up station or the like substantially as explained in conjunction with Figure 1.

Referring now to Figure 3 wherein a forming-section 30 is partially illustrated. A headbox 11 having a slice chamber 11a with an outlet 11e that is adjustable, by virtue of adjustment means PA, is positioned in working relation to the forming gap G. Two breast rolls 15 and 16 are mounted for rotation and define therebetween a horizontally-extending gap G. The spacing between the breast rolls is of a greater dimension than the ribbon-thin jet-stream exiting from the opening 11e. Two forming-wires F_1 and F_2 wrap the breast rolls 15 and 16 respectively and are guided through the initial close spacing at the gap G to define a forming throat. It will be noted that the outlet 11e is orientated generally upwardly to feed the jet-stream of co-moving fibres into contact first with the upper wire, i.e., F_1 and then with the other wire. This orientation allows substantial amounts of water to be driven through the upper wire. The wires then continue travelling convergingly together into general parallelism over a third wire guide 28 and attain such parallelism (which has heretofore been defined as a dynamic relation undergoing slight geometric changes as water is removed from the new web) at a point 28a substantially along the surface of wire guide 28. The forming-wires F_1 and F_2 are trained over a plurality of wire guides as indicated hereinbefore to define first and second wire runs which are driven at substantially jet-stream speeds and maintained under tension as desired.

The jet-stream exiting from the opening 11e of the chamber 11a impinges on the travelling wires F_1 and F_2. Since the wires are travelling in a converging relationship relatively "easy" pressure is applied on the jet-stream and dewatering occurs by an essentially drainage phenomenon in directions away from the jet-stream direction. Thus, a first dewatering area A_1 occurs at the immediate off-running side of the breast roll 15 and a second dewatering area A_2 occurs at the immediate off-running side of the breast roll 16. Additional dewatering takes place as the wires continue to converge together into general parellelism at a point 28a. As the wires travel in such parallelism substantially greater pressure is gradually applied on the jet-stream and additional dewatering takes place along a third dewatering area A_3 through the exposed side of the forming-wire F_1 which is free from contact with restraining means. The "easy" pressure referred to herein is generally defined as a compromise between abrupt pressure necessary to expel air from a web and slowly increasing or intensified pressure causing spreading or spewing of the paper stock beyond the wires.

The third wire guide 28 presents a substantially water-permeable surface to the second wire run F_2 and is defined by a plurality of longitudinally spaced, generally transverse wire-contacting relatively thin edges 28b. The longitudinal contour of the wire-contacting edges 28b define the elongated convex curve of the wire guide 28. The relatively large radius of curvature of the guiding surface of the wire guide 28 prevents substantial normal or perpendicular pressure loading of the wires against the wire, thereby preventing undue frictional engagement between the travelling wires and the guiding surface of the wire guide 28. Wire guide 28 includes a housing for maintenance of sub-atmospheric pressure at the water-permeable surface to aid water removal through the longitudinal spacing between the wire-contacting edges 28b past the second wire run at such forming zone. The wire guide 28 is provided with a conduit C for directing water away from the longitudinal spacing between the wire-contacting edges. Thus, the water-permeable surface of the wire guide 28 defines a fifth dewatering area A_5 substantially opposed to the third dewatering area A_3. While the wire guide 28 preferably has a convexly-curved surface, it will nevertheless be appreciated that an essentially flat surface may also be utilized. In this manner, it will be noted that the newly formed web is continuously dewatered along substantially opposed sides, allowing proper distribution of fibres within the newly forming web.

The sandwich arrangement continues travelling in the jet-stream direction to contact a relatively large diameter foraminous roll 19. The roll 19 has an "open" surface 19a substantially as indicated hereinbefore and presents a rotating open surface to the travelling sandwich arrangement to guide the same through a substantial curve away from the jet-stream direction at a rate of turn sufficient to define a fourth dewatering area A_4, driving water through and away from the exposed side of the first forming-wire F_1. Water is also driven into the openings of the surface 19a of the roll 19. A stationary, laterally continuous dewatering means 19b is provided at the immediate off-running side of the roll 19 is skim any adhering water from the rear side of the forming-wire F_1. The forming-wire then continues to travel past a further dewatering station and to a pick-up nip substantially as discussed in conjunction with Figures 1 and 2.

In summation, it will be noted that the present invention provides a relatively long forming-zone having simultaneous drainage through opposed sides of the newly forming web for formation of an exceptional paper web. The rate of drainage in the forming-zone is adjustable by utilization of sub-atmospheric pressure and by the utilization of adjustable wire tensions in the forming wires. The gradual build-up of pressure between the wires during their travel through the forming zone avoids spreading and spewing of large volumes of water from between such wires and also avoids flow disturbances due to the abrupt pressure changes that would otherwise occur between travelling wires. This allows a wide range of web-weights to be formed in a single forming-section. In addition, the low drag on a travelling wire through the forming-zone reduces wire wear and the bi-radii path of travel which the forming-wires take in the forming-zone presents normal loading of the wires against the stationary surface but allows realtive greater loading to occur at the rotary surface thereof, thereby avoiding frictional wear. In addition, the compact design of the forming-section allows the utilization of increased operational speed and/or greater web-weight without increases in floor space or head space of the forming machine. The preferred slice chamber provides an ideal mating with the forming-section to produce exceptional paper webs, since the forming-section has no shear-promoting device along the forming-zone and provides a relatively long path of travel for the "free" jet-stream up to the area of convergence between the travelling wires. The fourth guide 19 has herein been referred to as "foraminous". This term will be understood to include a surface having sufficient open area to avoid detrimental "pumping" of water from a moving moist web or the like.

WHAT WE CLAIM IS:—

1. Apparatus for forming fibrous webs comprising two looped foraminous wires disposed in continuous loops or runs, and a headbox for introducing papermaking stock between the wires at an entrance mouth defined by opposed parts of the wire loops or runs, said opposed parts extending round a stationary curved guide having a large radius of curvature and a rotatable guide having a substantially smaller radius of curvature than that of the stationary guide, the stationary guide and the rotatable guide being positioned within the loop of one of the wires and urging the said one of the wires toward the second of the wires.

2. Apparatus as claimed in claim 1, wherein the stationary wire guide has a generally convexly curved surface.

3. Apparatus as claimed in claim 1 or 2, wherein the rotatable wire guide is in the form of a solid roll, or a pervious roll or a wire-wrapped roll affording drainage in both directions, positioned on the immediate off-running side of the stationary guide.

4. Apparatus as claimed in claim 1, 2 or 3, wherein the stationary and rotatable wire guides defined a bi-radii curved path of travel having a first radius of curvature substantially larger than the second radius of curvature.

5. Apparatus as claimed in any one of the preceding claims, wherein the stationary wire guide presents either a substantially water-pervious or impervious surface to the second wire run.

6. Apparatus as claimed in claim 5, wherein the said substantially water-pervious surface is defined by a plurality of longitudinally-spaced, generally transverse, wire-contacting relatively thin edges, the longitudinal contour of the wire-contacting edges defining an elongated convex curve.

7. Apparatus as claimed in claim 6, wherein the stationary guide includes a housing for maintenance of subatmospheric pressure at the water-pervious surface thereof for water removal through the longitudinal spacing between the wire-contacting edges.

8. Apparatus as claimed in any of the preceding claims, wherein a wire guide downstream of the rotatable guide is adapted when in operation to direct one of said wires away from the web carried on the other wire.

9. Apparatus as claimed in claim 8, wherein a pick-up felt wrapped roll is adapted when in operation to engage and remove the web from said other wire.

10. Apparatus as claimed in claim 1, comprising a slice chamber which has an outlet opening and an upper and lower wall converging toward the opening; a plurality of flexible trailing elements within the slice chamber defining therein a plurality of converging channels extending toward the outlet and adapted when in operation to feed the said dilute aqueous suspension having a relatively low degree of turbulence and a high degree of dispersion of co-moving fibres as a high-speed ribbon-thin, substantially unidirectional jet-stream towards the outlet opening, first and second breast rolls being spaced apart a distance greater than the ribbon-thin jet-stream of stock to define a gap perpendicular to the jet direction receiving the jet-stream therebetween.

11. Apparatus as claimed in claim 10, wherein the outlet opening of the slice chamber is adapted to be adjusted in accordance with the width of the gap.

12. Apparatus as claimed in claim 10 or 11, wherein an additional guide presents a stationary curved water-removing surface to the travelling wire runs when in operation.

13. Apparatus as claimed in claim 10, 11 or 12, wherein the generally curved surface of the additional guide includes a relatively large radius of curvature preventing substantially normal pressure loading on the forming wire runs.

14. Apparatus as claimed in any one of claims 10 to 13, wherein the slice chamber outlet opening is orientated to feed the aqueous suspension of co-moving fibres generally upwardly in respect to the forming wire runs adapted to travel over the breast rolls, whereby the aqueous suspension contacts one of the wire runs before the other.

15. Apparatus for forming a fibrous web from a dilute suspension of fibres, substantially as described with reference to Figure 1 or Figure 2 or Figure 3 of the accompanying drawings.

Agents for the Applicants.
STANLEY, POPPLEWELL, FRANCIS & ROSS,
Chartered Patent Agents,
20—21 Tooks Court,
Cursitor Street,
London, EC4A 1LB.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1972.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1288277 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

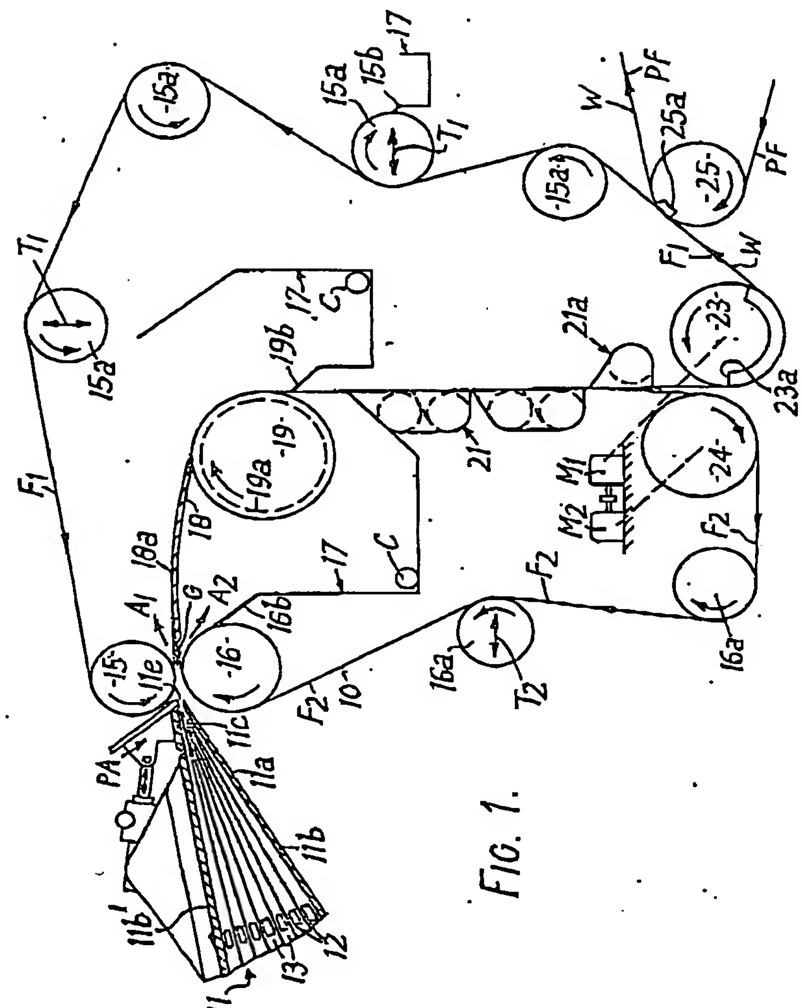


FIG. 1.

FIG. 2.

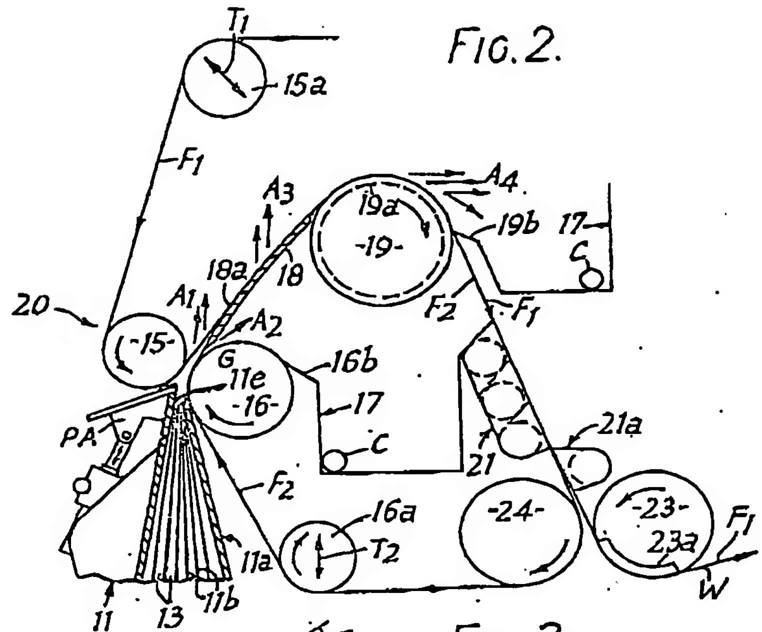
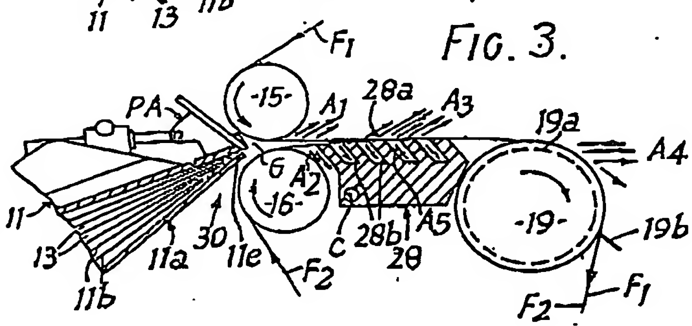

T1
15a
F1
A3
19a
-19-
A4
19b
17
C
18a
18
20
A1
A2
F2
F1
-15-
G
11e
-16-
16b
17
PA
C
21a
21
F2
16a
-24-
-23-
23a
F1
T2
11a
W
11
13
11b

FIG. 3.


F1
PA
-15-
A1
28a
A3
19a
A4
G
A2
-16-
-19-
19b
11
13
11a
30
11e
C
28b
A5
28
F2
F2
F1
11b

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- [x] BLACK BORDERS
- [ ] IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- [ ] FADED TEXT OR DRAWING
- [x] BLURRED OR ILLEGIBLE TEXT OR DRAWING
- [ ] SKEWED/SLANTED IMAGES
- [ ] COLOR OR BLACK AND WHITE PHOTOGRAPHS
- [ ] GRAY SCALE DOCUMENTS
- [ ] LINES OR MARKS ON ORIGINAL DOCUMENT
- [ ] REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- [ ] OTHER: ______________________

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.